Defense Nuclear Agency
Alexandria, VA 22310-3398

DNA-TR-94-2

Weapons Effects and Performance Data Archival Program

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March 1996

Technical Report

CONTRACT No. DNA 001-92-C-0049

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REPORT DOCUMENTATION PAGE		Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave Blank)*	2. REPORT DATE 960301	3. REPORT TYPE AND DATES COVERED Technical 920501 - 931231

4. TITLE AND SUBTITLE
Weapons Effects and Performance Data Archival Program

5. FUNDING NUMBERS
C - DNA-001-92-C-0049
PE - 62715H
PR - AC
TA - AH
WU - DH323140

6. AUTHOR(S)
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Horizons Technology, Inc.
P.O. Box 23812
San Diego, CA 82123

8. PERFORMING ORGANIZATION REPORT NUMBER
HTI-SD-94-D001

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Defense Nuclear Agency
6801 Telegraph Road
Alexandria, VA 22310-3398
PMCT/Wolfe

10. SPONSORING / MONITORING AGENCY REPORT NUMBER
DNA-TR-94-2

11. SUPPLEMENTARY NOTES
This work was sponsored by the Defense Nuclear Agency under RDT&E RMC Code B 4662 D AC AH 00011 1110 A 25904D.

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*
This report describes the development and application of software for the archival and retrieval of textual, audiovisual, and other types of data on the effects and performance of conventional weapons. A multimedia database management system, called the Weapons Effects And Performance Data Archival (WEAPDA) Information System, was developed to archive and retrieve comprehensive information covering operational uses of conventional weapons on various target types. This software system and associated databases will support various analyses including delivery accuracy, weapon effectiveness, weapons system reliability, and target vulnerability.

14. SUBJECT TERMS
Weapons Effects, Multimedia Database, Digital Video, DESERT STORM, Data Archival

15. NUMBER OF PAGES
56

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	SAR

CLASSIFIED BY : N/A since UNCLASSIFIED

DECLASSIFY ON : N/A since UNCLASSIFIED

SUMMARY

The Persian Gulf War created vast amounts of valuable textual and visual data on the effectiveness and performance of modern conventional weapon systems. As a result, numerous studies were initiated to harvest as much information as possible from the available data. No comprehensive effort was undertaken, however, prior to the war to organize the capture, consolidation, linking and archival of the most critical weapons effects and performance data. Much of the data, which included satellite imagery, battle damage assessment (BDA) photos, captured design drawings, armament delivery records (ADRs), and eye witness experience of key personnel, was lost in theater or never recorded. Other key data was dispersed to numerous locations in the United States and abroad.

The Weapons Effects And Performance Data Archival (WEAPDA) project was initiated to consolidate these data, insert them in digital form into a permanent archive, and make them readily accessible to users. The resulting WEAPDA system is a digital, multimedia database management system, operating on a Personal Computer (PC) in a Microsoft Windows® environment. It provides a simple, graphical and intuitive user interface to assist the user with data retrieval. Due to the large amount of data, the digital information (both text and imagery) are stored on Compact Disk-Read Only Memory (CD-ROM).

Three full WEAPDA systems have been fielded to date and have generated considerable interest. A number of future applications for the system are being considered including a portable system capable of capturing the data in the field as it is generated (during the next conflict or live weapons test), BDA analyses, and training and education.

PREFACE

The development of the Weapons Effects And Performance Data Archival (WEAPDA) hardware/software system required the integration of a wide range of data, software development and hardware integration skills, encompassing several emerging technologies. Both the Government and the prime contractor, Horizons Technology, Inc., worked closely together, and diligently, to ensure success. The Project Manager for HTI was Mr. Geoffrey Butler, with key support from Mr. Bill Lee, Mr. Steve Mehler, Mr. Wil Sensenderfer and Mr. Joe Squeo. For the Defense Nuclear Agency, Capt. James Welter was the Contracting Officer's Technical Representative, with assistance from Lt. Col. (retired) David Artman, Major David Pyle, and Major Ed Wolfe.

The development of the WEAPDA information system also benefited heavily from the diligent work and support of many individuals and their organizations who assisted the effort by providing expertise and/or data relating to the use of conventional weapons. These included the Defense Nuclear Agency, Air Combat Command, the National Archives, the Gulf War Air Power Survey, the Joint Technical Coordinating Group for Munitions Effectiveness, the Air Force Wright Laboratory, the Motion Media Center, the Army Corps. of Engineers, the 37th Tactical Fighter Wing, the Air Force Center for Studies and Analyses, and the Defense Intelligence Agency.

The authors wish to extend their appreciation to all the aforementioned individuals and organizations, as well as the countless other persons who contributed directly or indirectly to this project.

CONVERSION TABLE

Conversion factors for U.S. Customary to metric (SI) units of measurement.

MULTIPLY → BY → TO GET
TO GET ← BY ← DIVIDE

angstrom	1.000 000 X E-10	meters (m)
atmosphere (normal)	1.013 25 X E +2	kilo pascal (kPa)
bar	1.000 000 X E +2	kilo pascal (kPa)
barn	1.000 000 X E -28	$meter^2$ (m^2)
British thermal unit (thermochemical)	1.054 350 x E+3	joule (J)
calorie (thermochemical)	4.184 000	joule (J)
cal (thermochemical)/cm^2	4.184 000 X E -2	mega joule/m^2 (MJ/m^2)
curie	3.700 000 x E+1	*giga becquerel (GBq)
degree (angle)	1.745 329 x E-2	radian (rad)
degree Fahrenheit	$t_k = (t°f + 459.67)/1.8$	degree kelvin (K)
electron volt	1.602 19 X E -19	joule (J)
erg	1.000 000 X E -7	joule (J)
erg/second	1.000 000 X E -7	watt (W)
foot	3.048 000 X E -1	meter (m)
foot-pound-force	1.355 818	joule (J)
gallon (U.S. liquid)	3.785 412 X E -3	$meter^3$ (m^3)
inch	2.540 000 X E -2	meter (m)
jerk	1.000 000 X E +9	joule (J)
joule/kilogram (J/kg) radiation dose absorbed	1.000 000	Gray (Gy)
kilotons	4.183	terajoules
kip (1000 lbf)	4.448 222 X E +3	newton (N)
kip/$inch^2$ (ksi)	6.894 757 X E +3	kilo pascal (kPa)
ktap	1.000 000 X E +2	newton-second/m^2 ($N\text{-}s/m^2$)
micron	1.000 000 X E -6	meter (m)
mil	2.540 000 X E -5	meter (m)
mile (international)	1.609 344 X E +3	meter (m)
ounce	2.834 952 X E -2	kilogram (kg)
pound-force (lbs avoirdupois)	4.448 222	newton (N)
pound-force inch	1.129 848 X E -1	newton-meter (N·/m)
pound-force/inch	1.751 268 X E +2	newton/meter (N/m)
pound-force/$foot^2$	4.788 026 X E -2	kilo pascal (kPa)
pound-force/$inch^2$ (psi)	6.894 757	kilo pascal (kPa)
pound-mass (lbm avoirdupois)	4.535 924 X E -1	kilogram (kg)
pound-mass-$foot^2$ (moment of inertia)	4.214 011 X E -2	kilogram -$meter^2$ (kg·m2)
pound-mass/$foot^3$	1.601 846 X E +1	kilogram/$meter^3$ (kg/m^3)
rad (radiation dose absorbed)	1.000 000 X E -2	**Gray (Gy)
roentgen	2.579 760 X E -4	coulomb/kilogram (C/kg)
shake	1.000 000 X E -8	second (s)
slug	1.459 390 X E +1	kilogram (kg)
torr (mm Hg, 0° C	1.333 22 X E -1	kilo pascal (kPa)

* The becquerel (Bq) is the SI unit of radioactivity; 1 Bq = 1 event/s.

** The Gray (GY) is the SI unit of absorbed radiation.

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SECTION 1

INTRODUCTION

1.1 BACKGROUND.

The impact of low cost, personal computer (PC) based multimedia computer systems and applications are just now beginning to be felt in the commercial and government markets. Their capability to display textual information, coupled with detailed graphics, still photographs and recently even full-motion video, has naturally led to applications involving education and training. These initial applications have proven the viability and cost-effectiveness of these systems, yet to date only a fraction of the potential applications for this technology are available or under development.

The recent introduction of compact disks (CDs) for data storage has further extended the range of applications for PC-based tools. With read only memory (ROM) storage capacity of more than 600 megabytes, educational materials, training manuals, and other cumbersome printed material consisting of thousands of pages of text and illustrations can now be placed on a single disk. In addition, the digital format combined with an estimated useful life of 25+ years, means that the information stored on CDs can be recovered flawlessly for decades.

Many uses exist for multimedia systems employing CD-ROM storage. This report addresses the development of one such application by the Defense Nuclear Agency, which was initially designed to archive and rapidly retrieve data of all types (textual, photographic, video and others) on the performance and effects of conventional weapons used in the Persian Gulf War. This basic functionality has now been expanded to cover other data in various media, particularly visual information such as photographs and video segments, of use to the weaponeering and/or targeteering community at large.

1.2 SYSTEM REQUIREMENTS.

The system concept called for operation as a personal workstation capable of storing and rapidly accessing large amounts data in various media (textual, photographic, full-motion video, etc.). Initially, these data were to provide as thorough coverage as possible of the operational use of conventional weapons during the DESERT STORM conflict. The ensuing database would then be used to support a variety of analyses of weapon system performance as well as the development of a knowledge base for munitions effects assessment. Since its initial release, the system has taken on the duties of a database management "shell," through which all types of interrelated data can be accessed. To realize these goals, data storage, hardware and software requirements were generated, as discussed in the following sections.

1.2.1 Hardware Requirements.

The system was required to operate using off-the-shelf hardware. No system unique hardware was to be developed or applied.

1.2.2 Data Storage Requirements.

An existing textual database, developed by the Air Combat Command (ACC) and the Gulf War Air Power Survey office under dBASE®, was identified as the initial source database. This database consisted of 30,599 records covering the air-to-surface missions flown during the DESERT STORM conflict. In addition to these data, WEAPDA was to archive and retrieve thousands of pre- and post-attack still photographs of the targets which were attacked, over 5000 full-motion videos and accompanying audio of the weapons being delivered on the target, as well as interviews with seven munitions effects assessment exploitation team members.

These interviews were highly valuable for their information content. The exploitation team members assessed the weapons effectiveness on-site, just after the cessation of hostilities, and provided expert opinions of the weapons effects.

Although these specific data requirements were known, the system was to remain flexible in order to accept other types of data (structural diagrams, maps, etc.) and data from other sources (other conflicts, test programs, etc.). Because of the large amounts of data already identified, and the fact that more data was likely to require storage at a later date, the database behind WEAPDA was also to be designed for enhanced efficiency. Due to the large amount of information to be stored, WEAPDA was to maximize its use of digital compression technology in order to minimize storage requirements.

1.2.3 Software Requirements.

The software was to provide a flexible, intuitive user interface enabling a researcher or analyst to locate, sort, and extract desired information. Because users with varying backgrounds and interests were expected to use the system, data retrieval was to be straight-forward, and yet provide users with varying avenues for the retrieval of desired information.

The software also had to provide on-demand display of color still photographs and full-motion (30 frames per second) color video with audio. The capability to add, modify or delete data, in these varying media, was also required. The system architecture was also to remain flexible and allow for future growth.

SECTION 2

SYSTEM DEVELOPMENT

Version 1.0 of the WEAPDA system was developed under a rapid prototyping effort and was fielded for operational testing eight months after contract award. Several challenges were encountered and overcome during the system development, as discussed below.

2.1 DATABASE DESIGN.

The WEAPDA version 1.1 shell houses three individual databases. These include the DESERT STORM - DoD, DESERT STORM - UNCL, and Air Campaign Planning Model (ACPM) databases. Each of these databases was individually tailored to the data it was to store, and accessed via the SEARCH and VIEW menus of the WEAPDA system. Information on the individual design of each database is presented in the following sections.

2.1.1 DESERT STORM - DoD.

An existing textual database, developed by the Air Combat Command (ACC) and the Gulf War Air Power Survey office under dBASE®, was identified as the initial source database. This database consisted of 30,599 records covering the air-to-surface missions flown during the DESERT STORM conflict. In addition to these data, WEAPDA was to archive and retrieve thousands of pre- and post-attack still photographs of the targets which were attacked, over 5000 full-motion videos and accompanying audio of the weapons being delivered on the target, as well as interviews with seven munitions effects assessment exploitation team members. These data, especially overhead photographs, were pertinent to several entries in the textual database. For example, a single overhead photograph of an Iraqi airfield, such as the example shown in Figure 2-1, might show several aircraft shelters, each of which is the target within a separate entry in the textual database. Therefore, had a "flat" database structure been used, the photograph would have been unnecessarily repeated as part of each record.

To avoid this inefficiency, a relational database structure was developed and employed. Translators were then developed to read the information from the dBASE® database and insert it into the WEAPDA relational structure described below. The resulting textual database "core" was then reviewed for accuracy and completeness through direct comparisons with the original dBASE® database.

The DESERT STORM - DoD database is modeled after a Network Database. A Network Database consists of records which are defined and maintained through sets. A set defines a one-to-many relationship between two record types. Examples of sets are:

- one Airplane has many Weapons
- one Target has many Missions

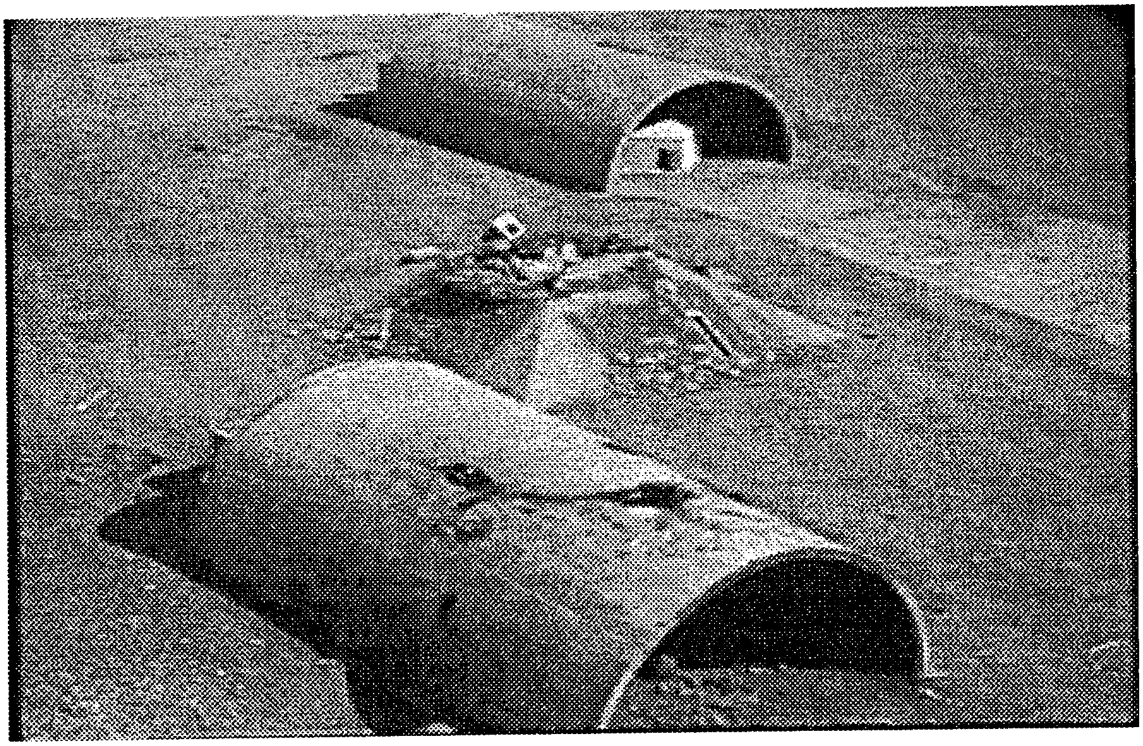

Figure 2-1. A single target is often the subject of multiple records within the database.

Figure 2-2 illustrates the relationship between different records in the database. The arrows represent sets that connect related records. The "pointer" is the owner, and the record being "pointed to" is the child. In each record there are also keys, which sort the database either in ascending or descending order on that key. Support tables used by the DESERT STORM-DoD database are shown in Figure 2-2 as the standalone boxes. These include Titles, Types, Deleted, Damage and Query, which are discussed in greater detail in Table 2-1. Also shown on the figure are the compound keys AAA, AAD, ADA, ADD, DAA, DAD, DDA, DDD which are brought to bear to hold data values during sorting. The compound keys are detailed in Table 2-2. Table 2-1 provides information on all fields contained in each record in the database. Within the table, keys are indicated by a preceding asterisk (*). This is followed by Tables 2-2 and 2-3, which list the compound keys and sets, respectively, for the database. These structures are essential to the network database definition, and allow the database manager to maintain the internal pointers, or relations, between database elements.

Finally, a unique record can be identified within the database by five fields. These are; 1) Basic Encyclopedia (BE) number, 2) Mission number, 3) Air Task Order (ATO) day, 4) Callsign, and 5) Linesort. No two records have the same entries in all of these fields.

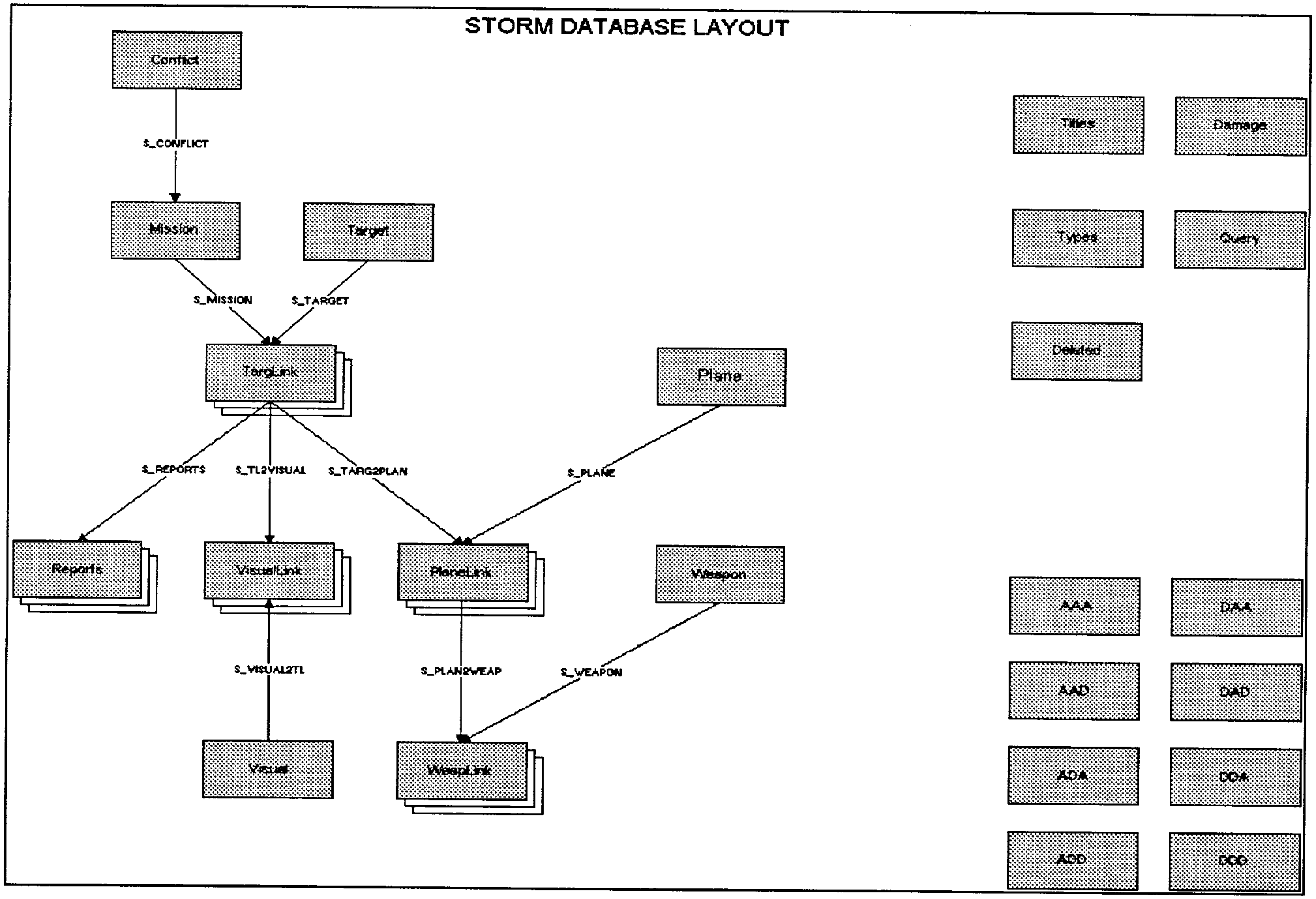

Figure 2-2. DESERT STORM - DoD database structure.

Table 2-1. DESERT STORM - DoD database fields.

Table	Type/Field [dimension]	Description
Conflict		Describes a single Conflict.
	char szName[40]	Name of Conflict i.e. Desert Storm
	long lStartDate	Start Date of Conflict, also ATO date
	long lEndDate	Date Conflict ended.
	char szSecurity[40]	security label for this database
	long lColor	color to display security label
Mission		Describes a single Mission
	*char szATodays[3]	Day of conflict this mission occured
	*char szMis_Num[10]	Mission Id
	*char szLineSort[2]	Line Sort
	char szPkg[4]	Package Id (Not Used)
	*long lMis_Type	Mission Type Id, see Types table.
	char szUnit[11]	Unit name
	char szUnit1[15]	Second unit name (Not Used)
	*char szCallSign[14]	Call Sign
	char szReqNum[9]	Request Number (Not Used)
	char szFltsrttl[3]	Total # of sorties flown
	int iNo_Flown	# flown (Not Used)
	int iNo_Success	# success (Not Used)
	char szBlackHole[5]	(Not Used)
	char bCancelled;	Was this mission cancelled (T or F)
	char szDirectedBy[13];	Directed By
	char bJStars;	(Not Used)
	char bScudMission;	(Not Used)
	char szWeather[69];	(Not Used)
	char szSrc[5];	(Not Used)
	long lMissChgDate;	Date this mission was modified last.
	long lMissChgTime;	Time this mission was modified last.
Target	Describes a single Target	
	*char szBE[11]	BE Number
	char szAIF_Name[39]	Target name
	char szCountry[3]	Country Id, name found in SYSTEM DB
	*char szCategory[6]	Category string
	*long lLatitude	Target Latitude
	char cLatDir	Latitude direction (N or S)
	*long lLongitude	Target Longitude

Table 2-1. DESERT STORM - DoD database fields (Continued).

Table	Type/Field [dimension]	Description
	char cLongDir	Longitude direction (W or E)
	char cTarget	Was this target targeted? (T or F)
	char szPriority[9]	CENTAF #
	char szTGTDesc1[255]	Target description
	char szTGTDesc2[255]	Continuation of target description
	long lTTM_Date	TTM Date in long format.
	*char szTTM_BENum[11]	TM BE number.
	char szTTY_Type[14]	TTM Type
	char szStatus[4]	Status
	*char cHard	Was target hardened? (T or F)
	long lTargChgDate	Date this target was modified last.
	long lTargChgTime	Time this target was modified last.
TargLink		Heart of database, links all data together.
	char szJanap[15]	(Not Used)
	int iStartHours	Hour mission was started
	int iStartMin	Minutes mission was started
	int iEndHours	Hour mission was over.
	int iEndMin	Minutes mission was over
	char szDMPI_1[41]	First point of impact
	char szDMPI_Loc_1[21]	Coordinate of first impact
	*char szDMPI_Cat_1[6]	Category code of first impact
	*char cDMPI_Hard_1	Was first impact point hardened?
	char szDMPI_2[41]	Second point of impact
	char szDMPI_Loc_2[21]	Coordinate of second impact
	*char szDMPI_Cat_2[6]	Category code of second impact
	*char cDMPI_Hard_2	Was second impact point hardened?
	char szRemarks[21]	Remarks about impact.
	char szRemarks1[256]	Continuation of remarks.
	long lTLChgDate	Date this record was modified last.
	long lTLChgTime	Time this record was modified last.
	char szFurtherExpl[31]	(Not Used)
	*char cSuperSet	(Future Use)
Reports		Describes a Report to a single mission.
	char szSource[11]	Source of report.

Table 2-1. DESERT STORM - DoD database fields (Continued).

Table	Type/Field [dimension]	Description
	char szDTG[10]	Report date time group.
	char szNum[4]	Report number.
	char szType[5]	Report type.
	char szImageTime[5]	Image Time.
	long lImageDate	Image Date.
	char szImageType[3]	Image Type
	int iOccupied	Occupied? (T or F)
	char szPhys_1[255]	Physical remarks
	char szPhys_2[255]	Physical remarks continued.
	char szFunct_1[255]	Functional remarks
	char szFunct_2[255]	Functional remarks continued.
	char szBDA_Ass[4]	BDA Assessment.
	char szAPhase[3]	Assessment Phase.
	long lDamage	Damage Mechanism.
Visual		Describes a single Visual File.
	*char szFilename[13]	File name of visual file.
	char szDisk[21]	CDROM Disk # where file is located.
	char szPath[21]	Path where file is located.
	char szFile_Desc[256]	Description of Visual.
	char szMedia_Type[20]	Media type (Still Photo, Overhead, etc.)
	char szMedia_Label[21]	Title of the Visual, as seen by users.
	char szDisk_Label[21]	Disk label
	char szVisualSrc[21]	Visual Source.
	char szDate_Aquired[9]	Date visual was acquired.
	char szRunTime[10]	Run time of visual if its a Video file.
	char cColor	Color present in the file? (T or F)
	char cAudio	Audio present in the file? (T or F)
	char szExpertise[21]	Expert.
VisualLink		Links a Visual record to the TargLink.
	int iNull	Void field, table cannot be blank.
Plane		Describes a single plane.
	*char szPlane[8]	Name of plane
	long lPlane	Unique Plane Id.

Table 2-1. DESERT STORM - DoD database fields (Continued).

Table	**Type/Field [dimension]**	**Description**
PlaneLink		Links a TargLink to a Plane.
	int iAc_Qty	Number of specific planes of types pointed to by PLANE table.
	int iHit	How many hit target
	int iMiss	How many missed target
Weapon		Describes a single weapon.
	*char szAc_Ord[12]	Name of Weapon.
	long lWeapon	Unique Weapon Id.
WeapLink		Links Weapon type to Plane
	int iAcOrdNum	Number of specidif weapons of types pointed to by WEAPON table.
	char szFuze[11]	Fuze setting.
	char szSCL[9]	planned ordnance
	char szArea_Coor[21]	Jumbled data
Titles		Used to display titles in Grid Window.
	*char szColName[40]	Title Label.
	*int iTitleId	Title Id.
Types		Maintains a list of Mission Types.
	*char szTypeName[40]	Mission Type name.
	*long lTypeId	Unique Mission Id.
Damage		Maintains a list of Damage Mechanism types.
	*char szDamage[40]	Damage Mechanism name.
	*long lDamageId	Unique Damage id.
Deleted		For Future Use - keeps track of deleted records.
	char szDelBE[11]	BE number of deleted record.
	char szDelMis_Num[6]	Mission number of deleted record.
	long lDelChgDate	Date this record was deleted.
	long lDelChgTime	Time record was deleted.

Table 2-1. DESERT STORM - DoD database fields (Continued).

Table	Type/Field [dimension]	Description
Query	Used to Sort and perform a Fuzzy search on database data. Contains all data	
	char cDeleted	Set to TRUE if this record does not match what user wanted.
	long lAddr	database address into TargLink table.
	*char szSortFld1[40]	Sort field 1 (See Compound Keys Table)
	*char szSortFld2[40]	Sort field 2 (See Compound Keys Table)
	*char szSortFld3[40]	Sort field 3 (See Compound Keys Table)
	char szFuzzyCall[13]	Callsign to be Fuzzy searched.
	char szFuzzyUnit[11]	Unit to be Fuzzy searched.
	char szFuzzyName[39]	Target name to be fuzzy searched.
	char szFuzzyDMPI1[41]	First impact point to be fuzzy searched.
	char szFuzzyDMPI2[41]	Second impact point to be fuzzy searched.
	char szQBE[11]	BE number of this record.
	char szQCategory[6]	Category code of this record.
	char szQLatitude[7]	Latitude coordinate.
	char szQLongitude[8]	Longitude coordinate.
	char szQStatus[4]	Status.
	char szQAc_Ord1[9]	First weapon type.
	char szQAc_Ord2[9]	Second weapon type.
	char szQMis_Num[6]	Mission number.
	char szQDate[11]	Mission date in mm/dd/yy format
	char szQMis_Type[14]	Mission type string.
	char szQPlane[8]	Plane.

Table 2-2. Compound keys in DESERT STORM - DoD database.

Key	Field	Description
AAA		Sorts Fields in Query table.
	szSortFld1 asc	Sorts first sort field in Ascending order
	szSortFld2 asc	Sorts second sort field in Ascending order
	szSortFld3 asc	Sorts third sort field in Ascending order

Table 2-2. Compound keys in DESERT STORM - DoD database (Continued).

Key	Field	Description
AAD		Sorts Fields in Query table.
	szSortFld1 asc	Sorts first sort field in Ascending order
	szSortFld2 asc	Sorts second sort field in Ascending order
	szSortFld3 desc	Sorts third sort field in Descending order
ADA		Sorts Fields in Query table.
	szSortFld1 asc	Sorts first sort field in Ascending order
	szSortFld2 desc	Sorts second sort field in Descending order
	szSortFld3 asc	Sorts third sort field in Ascending order
ADD		Sorts Fields in Query table.
	szSortFld1 asc	Sorts first sort field in Ascending order
	szSortFld2 desc	Sorts second sort field in Descending order
	szSortFld3 desc	Sorts third sort field in Descending order
DAA		Sorts Fields in Query table.
	szSortFld1 desc	Sorts first sort field in Descending order
	szSortFld2 asc	Sorts second sort field in Ascending order
	szSortFld3 asc	Sorts third sort field in Ascending order
DAD		Sorts Fields in Query table.
	szSortFld1 desc	Sorts first sort field in Descending order
	szSortFld2 asc	Sorts second sort field in Ascending order
	szSortFld3 desc	Sorts third sort field in Descending order
DDA		Sorts Fields in Query table.
	szSortFld1 desc	Sorts first sort field in Descending order
	szSortFld2 desc	Sorts second sort field in Descending order
	szSortFld3 asc	Sorts third sort field in Ascending order
DDD		Sorts Fields in Query table.
	szSortFld1 desc	Sorts first sort field in Descending order
	szSortFld2 desc	Sorts second sort field in Descending order
	szSortFld3 desc	Sorts third sort field in Descending order

Table 2-3. DESERT STORM - DoD sets.

Set	Description
S_CONFLICT	Connects Conflict to Mission

Table 2-3. DESERT STORM - DoD sets (Continued).

Set	Description
S_MISSION	Connects Mission to TargLink
S_TARGET	Connects Target to TargLink
S_REPORTS	Connects TargLink to Reports
S_TL2VISUAL	Connects TargLink to VisualLink
S_VISUAL2TL	Connects Visual to VisualLink
S_TARG2PLAN	Connects TargLink to PlaneLink
S_PLANE	Connects Plane to PlaneLink
S_PLAN2WEAP	Connects PlaneLink to WeapLink
S_WEAPON	Connects Weapon to WeapLink

2.1.2 Air Campaign Planning Model.

The Air Campaign Planning Model (ACPM) is also referred to as the Checkmate database and is also modeled after a Network Database. A Network Database consists of records which are defined and maintained through Sets. A Set is defined as a link from one record type to multiple records of another type, or one-to-many relationship between two record types. Figure 2-3 illustrates the ACPM database structure and the complete relationship between the records in the database. The arrow represent Sets that connect related records. The owner is the record which initiates the arrow, and the record which gets pointed to by the arrow is the child. As with Figure 2-2, supporting data tables are indicated by stand-alone boxes. These include ChkTitles, ChkQuery and ChkMisc described in Table 2-1 and the compound keys discussed in Table 2-5.

The database fields are summarized in Table 2-4. The table indicates keys within records by an asterisk before their name. These keys sort the records in the database by alphabetic order or numeric order, depending on the field type. Then when the records are retrieved they can be accessed in the desired order.

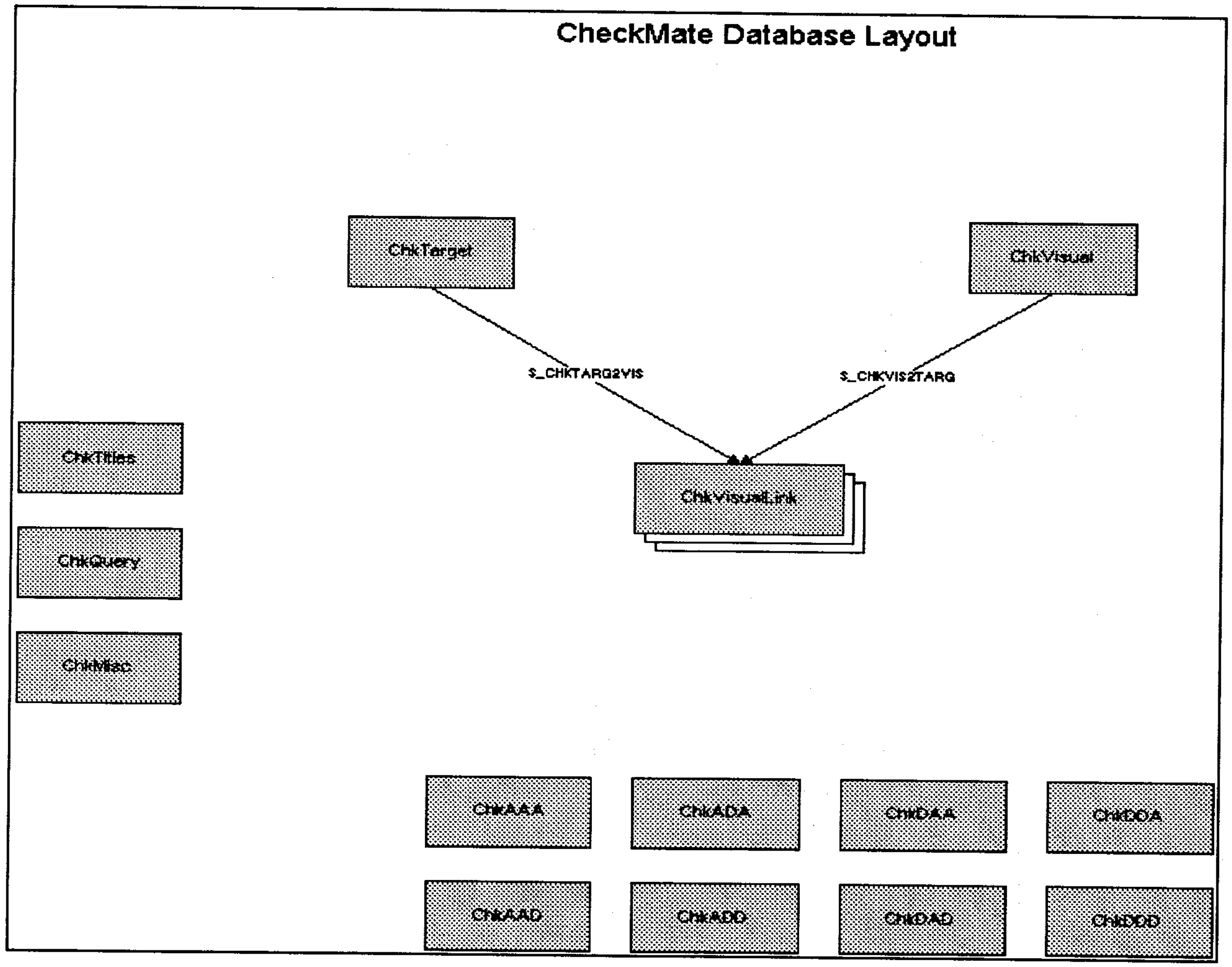

Figure 2-3. ACPM database structure.

Table 2-4. ACPM database fields.

Table	Type/Field [dimension]	Description
chkmisc		
	char szChkSecurity[40];	Security type for this database
	long lChkColor;	Color to display security
chktarget		
	*char szChkBE[11];	BE Number
	char szChkAIF_Name[39];	Target Name
	*szChkCountcharry[3];	
	*char szChkCategory[6];	Category code
	*long lChkLatitude;	Latitude of target
	*char cChkLatDir;	Latitude direction , either N or S
	*long lChkLongitude;	Longitude of target
	*char cChkLongDir;	Longitude direction, either W or E
	char szChkTGTDesc1[255];	Description of target
	*char cChkHard;	Describes if target was hardened.
chkvisual		
	*char szChkFilename[13];	Name of visual file
	char szChkDisk[21];	Disk where file located
	char szChkPath[21];	Path where file is located
	char szChkFile_Desc[256];	Description of visual file
	char szChkMedia_Type[20];	Describes the visual file.
	char szChkMedia_Label[21];	Title of file
	char szChkDisk_Label[21];	Label for disk.
	char szChkVisualSrc[21];	Source of material
	char szChkDate_Aquired[9];	Date file acquired.
	char szChkRunTime[10];	If video file, then time of video.
	char cChkColor;	True if color file
	char cChkAudio;	True if audio file
	char szChkExpertise[21];	
chkvisuallink		
	int iChkNull;	Void field, not used
chktitles		
	*char szChkColName[40];	Name of title displayed in Query result window.
	*int iChkTitleId;	Id of title

Table 2-4. ACPM database fields (Continued).

Table	Type/Field [dimension]	Description
chkquery		Maintains records to be sorted and fuzzy searched.
	char cChkDeleted;	If true then this record deleted.
	long lChkAddr;	Database address into database
	*char szChkSortFld1[40];	Sort field 1
	*char szChkSortFld2[40];	Sort field 2
	*char szChkSortFld3[40];	Sort field 3
	char szChkFuzzyName[39];	Target name to be fuzzy searched.
	char szChkQBE[11];	BE number of record.
	char szChkQCategory[6];	Category code of record
	char szChkQCountry[3];	Country of record
	char szChkQLatitude[8];	Latitude of record
	char szChkQLongitude[9];	Longitude of record
	char szChkQHard[2];	Is Target hardened?

In addition, compound keys (see Table 2-5) are used to sort the query result in ascending or descending order, depending on what three fields the user wanted and in what order they desire them. No more than three fields can be sorted.

Table 2-5. Compound keys in ACPM database.

Key	Field	Description
ChkAAA		Sorts all three fields in ascending order.
	szChkSortFld1 asc;	
	szChkSortFld2 asc;	
	szChkSortFld3 asc;	
ChkAAD		Sorts the first two fields in ascending order and the last descending.
	szChkSortFld1 asc;	
	szChkSortFld2 asc;	
	szChkSortFld3 desc;	
ChkADA		Sorts the first and last fields in ascending order and the second in descending order.

Table 2-5. Compound keys in ACPM database (Continued).

Key	Field	Description
	szChkSortFld1 asc;	
	szChkSortFld2 desc;	
	szChkSortFld3 asc;	
ChkADD		Sorts the first field in ascending order and the last two in descending order.
	szChkSortFld1 asc;	
	szChkSortFld2 desc;	
	szChkSortFld3 desc;	
ChkDAA		Sorts the first field in descending order and the last two in ascending order.
	szChkSortFld1 desc;	
	szChkSortFld2 asc;	
	szChkSortFld3 asc;	
ChkDAD		Sorts the first and last fields in descending order and the second in ascending order
	szChkSortFld1 desc;	
	szChkSortFld2 asc;	
	szChkSortFld3 desc;	
ChkDDA		Sorts the first field in descending order and the last two in ascending order.
	szChkSortFld1 desc;	
	szChkSortFld2 desc;	
	szChkSortFld3 asc;	
ChkDDD		Sorts all three fields in descending order.
	szChkSortFld1 desc;	
	szChkSortFld2 desc;	
	szChkSortFld3 desc;	

2.1.3 DESERT STORM - Uncl.

The DESERT STORM Unclassified database is also modeled after a Network Database. A Network Database consists of records which are defined and maintained through Sets. A Set is defined as a link from one record type to multiple records of another type, or one-to-many relationship between two record types. Figure 2-4 illustrates the structure of this database and the complete relationship between the records in the database. The arrow represent sets that connect related records. The owner is the record which initiates the arrow, and the record which gets pointed to by the arrow is the child.

Some records contain key fields, indicated by an asterisk before their name in Table 2-6. These keys sort the records in the database by alphabetic order or numeric order, depending on the field type. Then when the records are retrieved they can be accessed in a user defined order. This is followed by Tables 2-7 and 2-8, which list the compound keys and sets, respectively, for the database. As discussed earlier, these structures are essential to the network database definition, and allow the database manager to maintain the internal pointers, or relations, between database elements.

2.2 SOFTWARE DEVELOPMENT.

One key goal was to make the system operation highly intuitive, so that very little training would be required to prepare an operator to effectively use the system. To meet this goal, the software development proceeded in several phases.

First, significant effort was expended establishing the system conceptual design. Functional block diagrams, such as the one for the database editing function shown in Figure 2-5, were used extensively to ensure that the development team had a complete understanding of the system functions and interrelationships.

Then a number of brainstorming sessions were held to design the flow of operation of the software, as well as prepare sketches of preliminary user interface screens. By design, these sessions included individuals with a broad range of perspectives. Members included software engineers, experts in audiovisual data archival, weapon effects specialists and others.

With this task completed, the preliminary user interface screens were actually coded up and linked together, so that the flow of system operations could be demonstrated. This "skeletal" system was then critiqued internally by a broad panel of software users and developers. The results of this review were then used to fine tune the system operations.

At this point software was written to support key system operations such as searching the database and retrieving and displaying archived information. With key functions in place, a preliminary design review was then held for members of the user community.

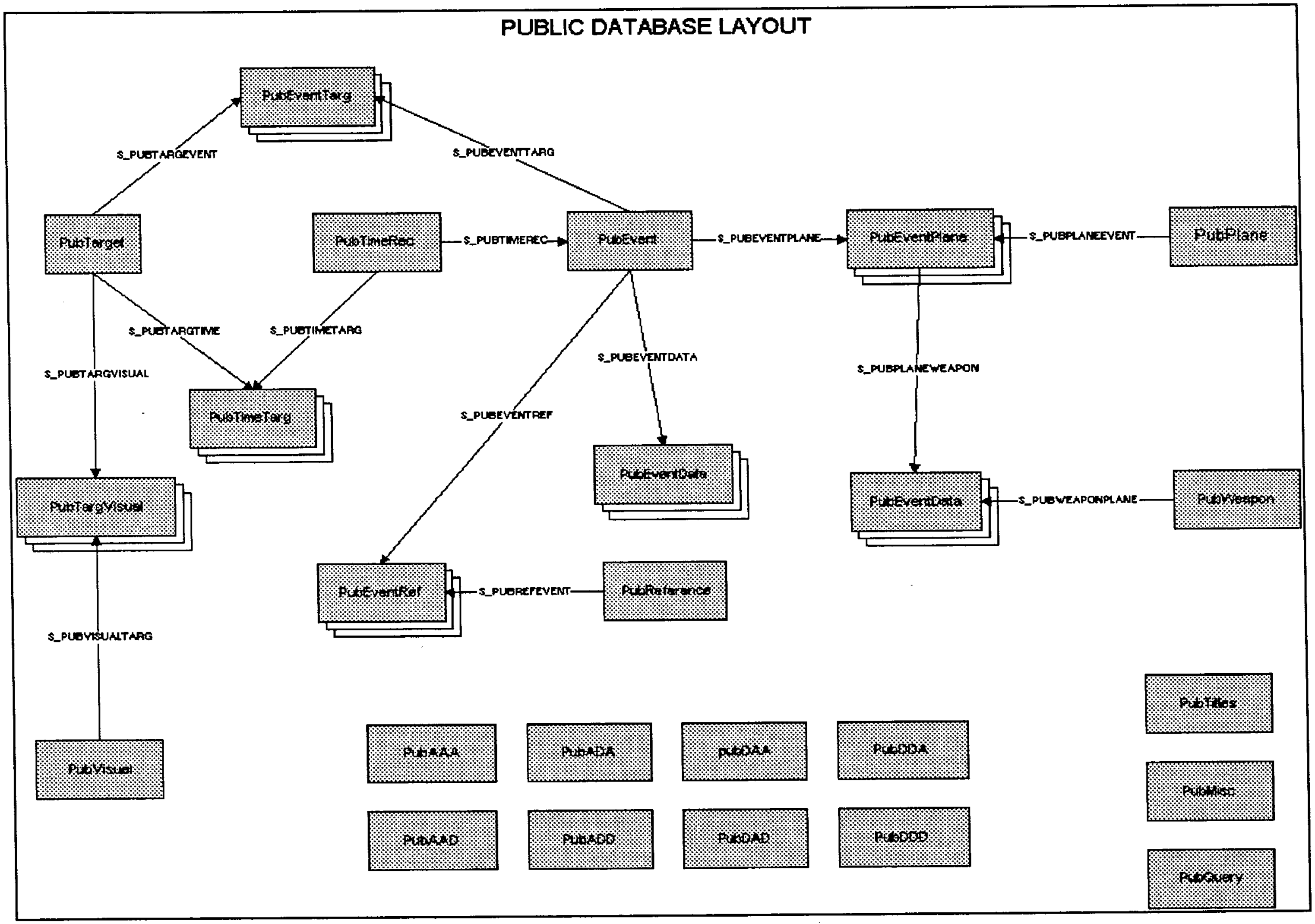

Figure 2-4. DESERT STORM - Uncl database structure.

Table 2-6. DESERT STORM - Uncl. database fields.

Table	Type/Field (dimension)	Description
pubtarget		Target information
	*char Pubname[39]	Target Name
	char Pubcity[20]	City where target found
	char Pubprov[20]	Not Used.
	*long Publat	Latitude of target
	*long Publong	Longitude of target
	char Publatdir	Latitude direction, N or S
	char Publongdir	Longitude direction, W or E
	int Pubcountry	Country Id
pubtimetarg		Chronological target information
	int PubTimeNull	Null Field, not used for anything.
pubtimerec		General chronological data
	*long PubAtoday	Days since start of war.
	int PubTotSorties	total # of sorties for this day
	int PubTotSortiesRef	Code use only, not used in database.
	int PubCENTAF	Centaf number for this day.
	int PubCENTAFRef	not used
	int PubMARCENT	Marcent number for this day.
	int PubMARCENTRef	not used.
	int PubNAVCENT	Navcent number for this day
	int PubNAVCENTRef	not used
	int PubAllied	Allied number for this day
	int PubAlliedRef	not used
	int PubOCA	OCA mission count
	int PubOCARef	not used
	int PubDCA	DCA mission count
	int PubDCARef	not used
	int PubInter	Interdiction mission count
	int PubInterRef	not used
	int PubCAS	CAS mission count
	int PubCASRef	not used
	int PubSEAD	SEAD mission count
	int PubSEADRef	not used
	int PubAirRefuel	Air refuelling
	int PubAirRefuelRef	not used
	int PubTactAirlift	Total TAC airlift

Table 2-6. DESERT STORM - Uncl. database fields (Continued).

Table	Type/Field (dimension)	Description
	int PubTactAirliftRef	TAC airlift reference
	int PubOtherSupp	Other support
	int PubOtherSuppRef	not used
	int PubNavySorties	Total Navy sorties
	int PubNavySortiesRef	not used
	int PubTotStrikeSort	Total strike sorties
	int PubTotStrikeSortRef	not used
	int PubTotRafSorties	Total RAF sorties
	int PubTotRafSortiesRef	not used
	int PubTotSortToDate	Total sorties to date
	int PubTotSortToDateRef	not used
	int PubNavMaritimeSort	Number of naval maritime sorties
	int PubNavMaritimeSortRef	not used
pubeventtarg		
	int PubEventNull	Null field
pubevent		
	*long PubEventType	Event type Id
	int PubTotalPlanes	Total planes on this event
	int PubNight	0 = Day mission, 1 = night mission
	long PubStartLoc	Bit values corresponds to which ship attack originated from
	long PubEventTime	Time of event
pubeventdata		
	char PubBuff[256]	Event data, if data is longer than 256 characters, multiple records of this type are linked together.
pubeventplane		
	int PubTotAC	Total number of a specific aircraft.
	char PubNationality[20]	Nationality of airplane, blank if US
pubplane		
	long PubPlaneType	Id of plane, each different plane gets a unique id.
	*char PubPlaneName[15]	Name of Plane, ie:F-15

Table 2-6. DESERT STORM - Uncl. database fields (Continued).

Table	Type/Field (dimension)	Description
pubplaneweapon		
	int PubTotWeap	Total number of weapons on a single plane.
pubweapon		
	long PubWeapType	Id of weapon, each different weapon gets a unique id.
	*char PubWeap[15]	Name of weapon.
pubtitles		
	*char PubColName[40]	Title name to be displayed in Query result window.
	*int PubTitleId	Id of title
pubmisc		
	char PubSecurity[40]	Security type to be displayed at top of query result window.
	long PubSecColor	Color of security type.
pubreference		
	*int PubRefId	Reference Id, think of these as footnotes.
	char PubRef[256]	Reference strings.
pubeventref		
	int PubRefNull	Null, not used.
pubvisual		
	*char PubFilename[13]	Name of visual file.
	char PubDisk[21]	Disk where file located.
	char PubPath[21]	Path on disk where file located.
	char PubFile_Desc[256]	Description of file
	char PubMedia_Type[20]	Type of file, ie:pictures, video, drawings,...
	char PubMedia_Label[21]	Title to describe the file.
	char PubDisk_Label[21]	Label
	char PubVisualSrc[21]	Where file was acquired.
	char PubDate_Aquired[9]	Date of acquisition
	char PubRunTime[10]	If video, length of video.

Table 2-6. DESERT STORM - Uncl. database fields (Continued).

Table	Type/Field (dimension)	Description
	char PubColor	True if color file
	char PubAudio	True if audio file
	char PubExpertise[21]	Expertise
pubtargvisual		
	int PubVisNull	Void field, not used
pubquery		
	char PubDeleted	Internal use only.
	long PubAddr	Database address of Time Record
	*char PubSortFld1[40]	Sort field 1
	*char PubSortFld2[40]	Sort field 2
	*char PubSortFld3[40]	Sort field 3
	char PubFuzzyName[39]	Target name to be fuzzy searched.
	char PubQueryLat[7]	Latitude
	char PubQueryLong[8]	Longitude
	char PubQueryWeap[40]	Weapon
	char PubQueryDate[11]	Date in yymmdd format
	char PubQueryType[40]	Event type, converted from long
	char PubQueryPlane[40]	Query plane
	char PubQueryLoc[20]	Query location
	char PubQueryData[80]	Query data type

Table 2-7. Compound keys in DESERT STORM - Uncl. database.

Key	Field	Description
PubAAA		Sorts all three fields in ascending order.
	szPubSortFld1 asc;	
	szPubSortFld2 asc;	
	szPubSortFld3 asc;	
PubAAD		Sorts the first two fields in ascending order and the last descending.
	szPubSortFld1 asc;	
	szPubSortFld2 asc;	
	szPubSortFld3 desc;	

Table 2-7. Compound keys in DESERT STORM - Uncl. database (Continued).

Key	Field	Description
PubADA		Sorts the first and last fields in ascending order and the second in descending order.
	szPubSortFld1 asc;	
	szPubSortFld2 desc;	
	szPubSortFld3 asc;	
PubADD		Sorts the first field in ascending order and the last two in descending order.
	szPubSortFld1 asc;	
	szPubSortFld2 desc;	
	szPubSortFld3 desc;	
PubDAA		Sorts the first field in descending order and the last two in ascending order.
	szPubSortFld1 desc;	
	szPubSortFld2 asc;	
	szPubSortFld3 asc;	
PubDAD		Sorts the first and last fields in descending order and the second in ascending order
	szPubSortFld1 desc;	
	szPubSortFld2 asc;	
	szPubSortFld3 desc;	
PubDDA		Sorts the first field in descending order and the last two in ascending order.
	szPubSortFld1 desc;	
	szPubSortFld2 desc;	
	szPubSortFld3 asc;	
PubDDD		Sorts all three fields in descending order.
	szPubSortFld1 desc;	
	szPubSortFld2 desc;	
	szPubSortFld3 desc;	

Table 2-8. DESERT STORM - Uncl sets.

Set	Description
s_pubtimetarg	Event time to target link
s_pubtargtime	Event target to time link
s_pubeventtarg	Target of event
s_pubtargevent	
s_pubtimeevent	Event time
s_pubeventdata	Event data
s_pubeventplane	Aircraft associated with event
s_pubplaneevent	Aircraft
s_pubplaneweapon	Weapon associated with event
s_pubweaponplane	Weapon
s_pubeventref	Event reference
s_pubrefevent	Reference
s_pubtargvisual	Visuals associated with event
s_pubvisualtarg	Target description for visual

Extensive notes were taken, and recommended system refinements were established.

This entire process, including two reviews of the system operations, was completed before the software coding was initiated. This streamlined the software development by minimizing changes once the coding was begun and also providing the development team a broadened understanding of the system as a whole so that code was developed right the first time.

All software was written in standard C to streamline future system maintenance and upgrade activities. A modular design approval was used so that individual functions could be more easily updated as software capabilities expand.

The WEAPDA system also incorporates a commercial off-the-shelf (COTS) software product named PhotoMagic™, by Micrographx®, for still image display and manipulation. At the time of this writing no multi-user licensee agreements for PhotoMagic have been negotiated, therefore, a copy of the software must be purchased for each WEAPDA station (approximate cost = $100.00). PhotoMagic offers the WEAPDA user key capabilities including image annotation, enhancements such as sharpen, show edges, and others, and the ability to save images in a variety of formats including Tagged Image File Format (TIFF), Graphical Interchange Format (GIF), and others.

2.3 SYSTEM HARDWARE.

The WEAPDA software is hosted on an upgraded stand-alone 486 desktop PC operating at 33 Mhz. Included with the basic PC are two 300 KB/sec CD-ROM drives, an 800 MB removable hard drive, a stereo speaker set, and 16 MB of random access memory (RAM). Fielded systems have been equipped with a 14 inch SVGA monitor, although future stations may opt for larger screen sizes.

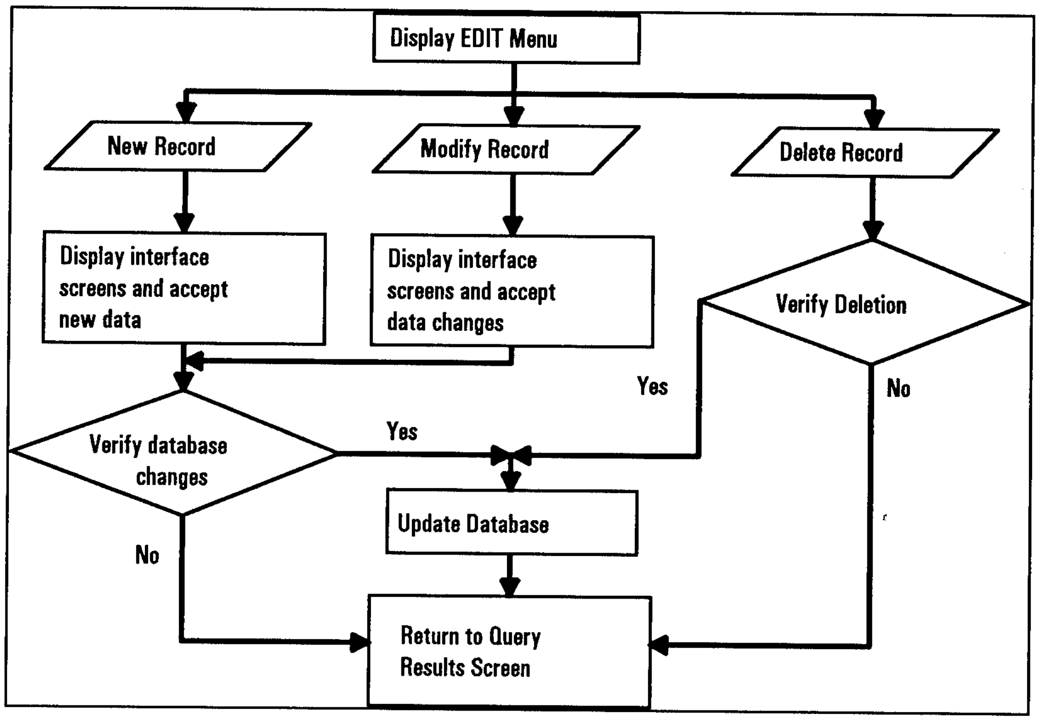

Figure 2-5. Sample conceptual design functional block diagram.

To support the unique capabilities of the WEAPDA system, some specific hardware was required. For full system utility, the items listed below, or their equivalent, were purchased and installed during Phase I.

- Full-height QUALITY tower case
- American Megatrends Inc. ISA-bus 80486-33 motherboard
- 16 MB DRAM
- Adaptec 1542B SCSI controller
- 500+ MB 3.5" SCSI hard drive
- Kingston DE1001-S and -CS 3.5" SCSI frame and carrier
- One Toshiba XM3401B and one NEC model CDR-83 2x speed CD-ROM players and drivers
- 1.2 and 1.44 MB floppy drives
- Intel ISA-bus ActionMedia II DVI delivery board

- Orchid Fahrenheit Super-VGA adapter with 1 MB VRAM
- Sony CPD-1304 multisync monitor
- Northgate OmniKey/101 keyboard
- Roland CS-10 Speaker System
- Computer to video scan converter

The above WEAPDA system hardware is installed much like any other micro computer system. The single most likely cause of confusion is the existence of 2 VGA ports on the back of the computer tower. One port, typically the upper one, is the standard VGA output. The other port, usually the lower one, is the port associated with the Digital Video Interactive (DVI) board, and is the proper one to which the monitor should be connected. Another way to recognize the proper VGA port is the existence of the audio output port directly beside the DVI VGA port.

Note that if the monitor is connected to the incorrect VGA port the computer will function normally until you attempt to view a video file, at which time a black window will be presented. If this occurs, refer to the instructions below.

For standard WEAPDA systems, the installation may be performed as follows.

1) Connect the monitor cable to the DVI VGA (lower) port.

2) Insert the 3/8 inch stereo input jack (single end) of the audio cable into the audio output port beside the VGA port.

3) Connect the two RCA standard audio connectors to the two ports labeled "Input 2" on the rear of the Roland CS-10 speaker unit. "Input 1" will also function correctly, but is designed to play at maximum volume.

4) Connect the A/C plug of Roland power transformer into a power strip* or wall socket, and connect the power output cable to the back of the speaker unit.

5) Connect the mouse to the mouse port (appears circular) on the back of the tower.

6) Connect the power cable provided to the plug located in the upper left corner at the of the tower and plug it into a power strip or wall socket.

7) Connect the monitor power cable provided to the monitor and power strip or wall socket.

8) Insert the removable hard drive firmly into the bay and turn the drive key counterclockwise to the horizontal (locked) position.

After completion of these steps, your system will be ready for operation.

Also note that it is highly recommended that a power strip with surge protection be used to provide power to the system hardware.

2.4 DATA ARCHIVAL AND DISPLAY.

WEAPDA is a true multimedia database management system allowing the user to access and review textual, visual and audio information including maps, technical drawings, full-motion video and pre- and post strike high quality color photographs.

Textual data is stored in an efficient relational database which can be rapidly searched, reviewed and edited.

Still images are stored digitally in a number of formats, depending upon the desired image resolution. When image display is requested, the system recognizes the storage format and applies the appropriate decompression and display algorithms. The image can then be modified by adding text and/or symbols to highlight key features. Image enhancement functions, such as zoom, negative image, rotation and color modification, are also available to assist the operator in clarifying features (see also Section 2.2).

The enabling technology for full-motion video display is Digital Video Interactive (DVI®), developed by Intel, which uses their i-750® chipset. This approach was selected principally for its good image resolution, symmetric (real time) capture capabilities, and ability to support other higher resolution formats[1]. In addition, the i-750® enables the highest quality video playback under Indeo®, which provides a scalable, cross-platform video playback architecture.

Due to its data intensive nature, video is being stored on Compact Disk-Read Only Memory (CD-ROM). Over 300 CD-ROMs have been produced in the initial phases of the project. The details of the contents of the Phase 1 CD-ROMs are presented in Section 2.5

WEAPDA Version 1.1 stores data related to the use of conventional weapons during the DESERT STORM air campaign, with emphasis on hardened and shallow-buried targets. This includes gun camera video of the actual weapon delivery during missions flown by the F-117, F-111, F-16 and F-15 aircraft, from weapon release through target impact. This is supplemented by satellite imagery and ground based still photography providing the pre- and post-attack data required to assess the effectiveness of the attack. Also included are interviews of exploitation team members providing expert assessments of weapon performance for selected key targets.

The system operates under Microsoft Windows™ 3.1, and takes full advantage of graphical user interfaces. Nearly all of the functions of WEAPDA are menu driven requiring a minimum of keystrokes, as illustrated by the Search menu shown in Figure 2-6.

[1]Walker, P.E. and Phlipot, M., "Off-line Time Asymmetric Compression Techniques for High Quality Digital Video," First International NAB/IMA Multimedia World Conference Proceedings, April 1993.

Textual data, such as the mission data shown in Figure 2-7, are presented upon request in individual windows, based upon data type, to aid comprehension.

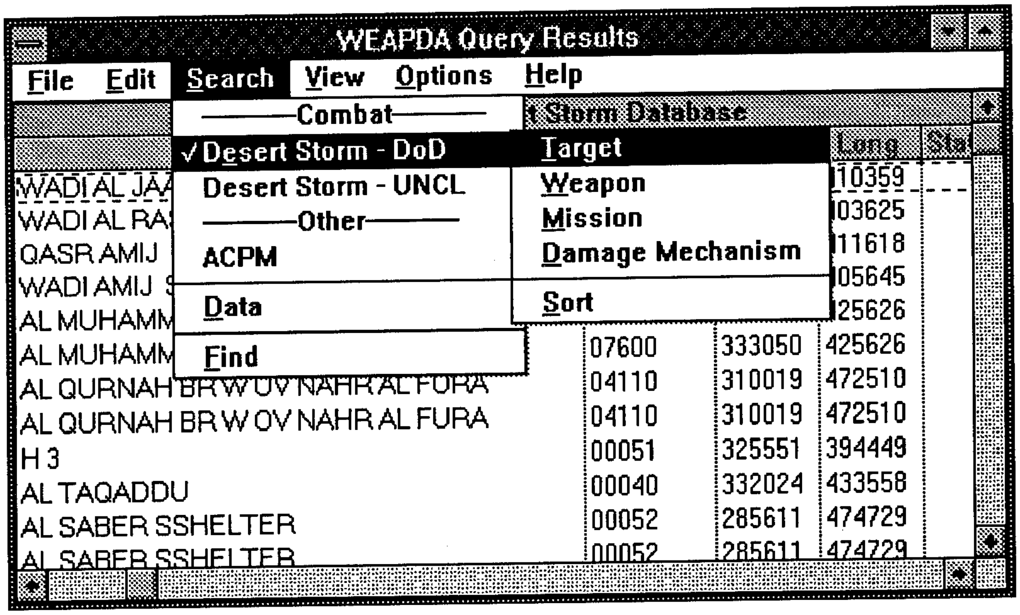

Figure 2-6. Search requests are prepared using simple pull-down menus.

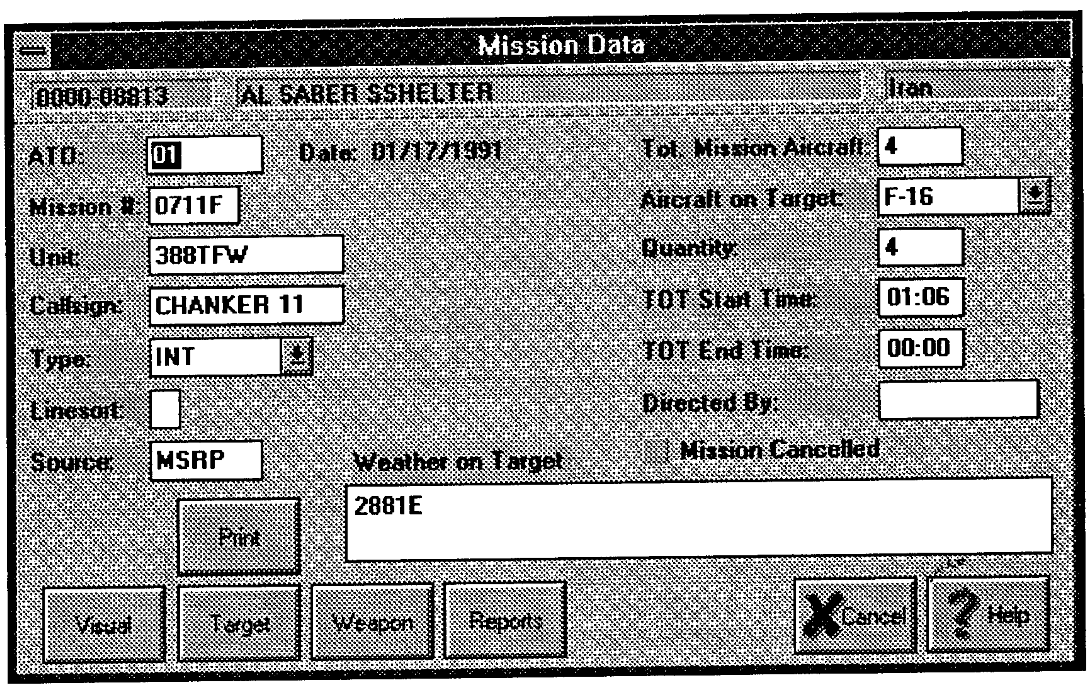

Figure 2-7. WEAPDA mission data summary screen.

The system is designed to help the novice user successfully retrieve and use the data contained. One of the features addressing this concern is a full-color, scrollable map function (Figure 2-8), which automatically tracks the mouse location on the digital map, and returns a requested search location. The details of the available maps including coverage and scale are provided in Section 2.4.1.3.

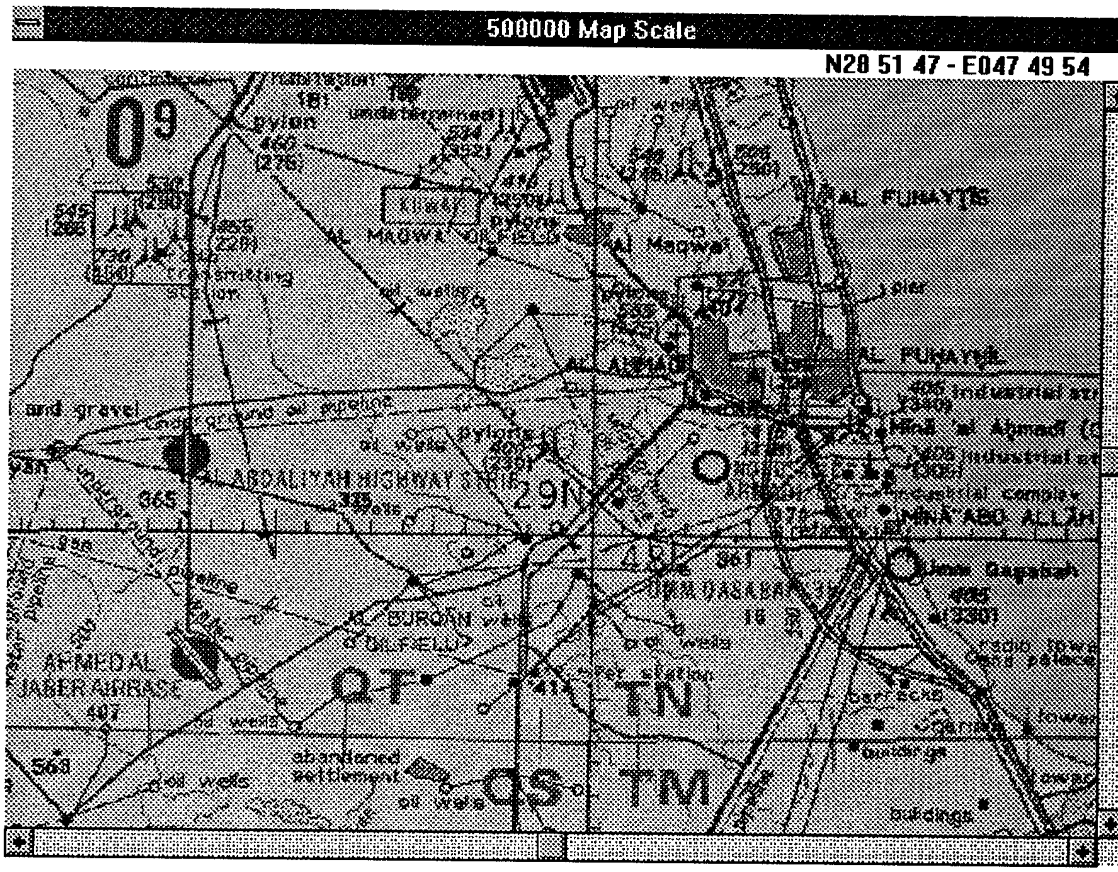

Figure 2-8. A number of digital maps assist the user with target location.

Finally, a help utility is available at all times to help the user with system operations, provide guidance, and define uncommon nomenclature.

2.4.1 Data Capture Process.

Data capture was performed using a variety of techniques. These included Real-Time Video (RTV) capture, for the ADR tape data, at 75 dpi (screen) resolution or better for the still color and B/W photographs, and commercial processing into the Kodak PhotoCD ™ format for unclassified imagery where negatives and/or slides were available. The details of both video and still image capture are discussed in the following sections.

2.4.1.1 Video Capture. Video capture was performed on an AST 486 tower using an ActionMedia II board set and commercial off the shelf (COTS) software. The software used and their capabilities and data capture characteristics are presented in Table 2-9. Video playback sources included both a 3/4" U-matic player, and an S-VHS deck. All signal compression included time-base correction for added stability, which is a basic requirement for the ActionMedia II board set.

The continuing evolution of the capture software brought on increased quality, and control over how capture was completed. These increases in quality were achieved primarily through increasing capture data rate. The latest software used for capture, Digital Video Producer (DVP), added additional flexibility for pre-capture control over video parameters, (i.e.: contrast, brightness, hue, and chroma saturation). Prior to this, adjusting video parameters was limited to playback operations only.

Table 2-9. Video capture software used.

Software	**Resolution/Data rate (Kb/sec)**	**Signal Encoding**	**File Format**
DVI Capture 1.0	160x120/ ≈ 150	NTSC	AVS
DVision 2.0	256x240/ ≈ 300	RGB/NTSC	AVS
Dime (Beta)	256x240/ ≈ 300	RGB	AVS
Digital Video Producer (DVP) 1.0	256x240/ ≈ 300	RGB	AVS

A file naming convention for video files was established as a way of indicating the method of compression used, as well as the type of video file. Efforts were made to adhere to the naming standards, which consisted of the following: R2A#####.AVS, R2V#####.AVS and R2I#####.AVS. The names breakdown as follows:

R = RTV Compression
2 = Algorithm level 2
A = contains audio (monophonic)
V = Video only, no audio data
I = Interview data, which includes both audio and video.
= numerical ID
.AVS = Audio Video Sub System extension

Note that video data compiled from the MEA exploitation team interviews from July 1992 were designated by R2I#####.AVS, in order to differentiate them from the monochromatic ADR mission video data.

During playback, resolution is directly related to data rate. In general, the higher the rate, the sharper the image. Resolution was also determined in part by compression method used. Real Time Video compression's quickness is facilitated by its "lossiness", meaning that the algorithm removes information that is highly repetitive. Real time capture was the

only reasonable compression scheme of choice, considering the enormous amount of data to be processed, cost involved, and the perishability of the data being captured.

Signal encoding was an item of contention. Early RTV work did not readily support RGB encoding, which later tests showed to be less "noisy" than when using a line level NTSC composite signal. The improvements in using RGB encoding are for the most part inconsequential, or negligible at best, considering that the ADRs were recorded in monochrome. By its nature, RGB's advantage lends itself to color video, not B/W. Regardless, when possible the signal was RGB encoded for capture using an NTSC to RGB break-out box.

Later software upgrades allowed for video file diagnostics and repair. Aberrations in video files, caused by capture software deficiencies, occasionally led to playback failures. Detection efforts begun during this effort have pinpointed files which may have format inconsistencies. These files are limited to the first six CD-ROM volumes produced (WEAPDA0001 - WEAPDA0006) and resulted from the early capture techniques then available (DVI Capture 1.0) which uses NTSC signal encoding. Although the files can be played back in their entirety, this technique causes problems to occur when using the "shuttle" feature to rapidly maneuver within a video, and can lead to a corrupt display. If this occurs, simply exit the video display window and hit the "shown" button again allowing the video to play through to completion. At the time of this writing, the limited availability of the WEAPDA CD-ROMs has prevented the development of a concise list of affected videos. Efforts were made to reconstruct problem files through editing. Recapturing problem clips was often impossible, since much of the material was on loan, and had been returned to the source location. Pending further study, the most feasible means to correct individual video clips may still require re-capture from the original video tapes.

2.4.1.2 Still image Processing. Still image processing involved many different methods. Some of the differences in processing methods went in step with technological capability, especially relating to images generated on PhotoCD material. Early image processing for slides and photos involved the use of a high-end three chip video camera, which was routed into an ActionMedia II equipped capture station. Images were captured at 16 bit color and at a 512x480 resolution. This method had several drawbacks. First, using a camera as the initial electronic processor introduced lens barrel distortions which appear in the images as convex outer edges. Secondly, the capture software used an output file which was incompatible with the Windows environment. As a result, a multi-step conversion process was initially undertaken to import the images into WEAPDA. With the acquisition of a flatbed scanner (HP Scanjet IIc) photos were digitized as 8 or 24 bit images, directly into Windows compatible graphic formats. This dramatically improved image quality, as well as eliminating the time-consuming format conversion step.

A slight drawback to processing with the flatbed scanner was that some oversized material did not physically fit onto the scanner bed. Oversized document pages required multiple,

overlapping passes, and then an edit step was needed to piece the elements together into a finished page. On occasion this process necessitated storage at different resolutions.

Slide materials which indicate multiple resolution do so due to the fact that they are PhotoCD images, and PhotoCDs offer a standard feature of maintaining five levels of resolution in a single file. For example, a given image will feature display resolutions ranging from thumbnail dimensions (128x192) to those of a fully detailed image (2048 x 3072).

To assist with data tracking and verification, a file naming convention was adopted. This convention not only indicates the type of image captured (e.g. targeting materials, or basic target graphics), but also the file format and sequence of the image. The convention reserves up to the first four characters of the file name for a designator of the image type, the following four characters convey the numerical sequence, with the file extension denoting the file format. The file names currently employed are as follows:

BDA#####.BMP/PCD; TR_#####.BMP; IRP#####.BMP; DS######.BMP; HTG#####.BMP; GTG#####.BMP; BTG#####.BMP; BDAL####.BMP; BDAH####.BMP

where:

BDA = Bomb Damage Assessment
BDAL = Bomb Damage Assessment Low Resolution (screen) used for DESERT STORM - Uncl. photos
BDAH = Bomb Damage Assessment High Resolution (150 d.p.i.) used for DESERT STORM - Uncl. photos
TR_ = Tactical Reconnaissance
IRP = Installation Reference Point
DS = Desert Shield
HTG = Hardened Target Graphic
GTG = Granby Target Graphic
BTG = Basic Target Graphic
= numerical ID
.BMP = format extension for Bit Map
.PCD = format extension for PhotoCD

An exception to this convention were the filenames assigned to MEA Photos, which simply built numerically in recognition of their likely use within other systems. For example, the 470th photo scanned is "00000470.BMP".

Table 2-10 presents a summary of the capture characteristics of the different groups of still imagery captured.

Table 2-10. Summary of still image capture statistics.

Image Type	Resolution	Bit Depth	Color or Black & White	Method	Format
MEA Team Photos	≈ 640x440	8	Both	scan	BMP
Tactical Reconnaissance	≈ 640x440	8	B/W	scan	BMP
Basic Target Graphic	Multiple	8	B/W	scan	BMP
Hard Target Graphic	Multiple	8	B/W	scan	BMP
Granby Target Graphic	Multiple	8	Both	scan	BMP
MEA Team Slides	≈ 512 X 480	16	Color	DVI Capture	BMP/ AVS
Howey slides	Multiple	24	Color	PhotoCD	PCD
Bomb Damage Assessment	multiple	8/24	Both	scan/PhotoC D	BMP/ PCD
Desert Shield materials	multiple	8	B/W	scan	BMP

2.4.1.3 Maps. There are a total of nine maps currently built into the WEAPDA system. The maps range in different scales, from 10K to 2M, and reside in their own sub-directory on the map CD. The sub directory name is made up from the map scale, class and zone on the earth. The following is a list of the various maps and the sub directory of where they reside on the disk:

- 10K map of Baghdad located in sub directory MAP4403 (Scale = 44, Class=0, Zone-3).
- 25K map of Baghdad, Mosul, and Basra located in sub directories MAP3502 and MAP3503. These are three distinct maps, and are located in two sub directories because they cover two different zones in the world.
- 250K map of conflict area located in sub directories MAP4682 and MAP4683.
- Two 500K map of conflict area located in sub directories MAP5602, MAP5603, MAP5682 and MAP5683. These two maps are identical except that the one located in MAP560x has a better palette.
- 800K map of conflict area located in sub directories MAP8512 and MAP8513.
- 2M map of conflict area located in sub directories MAP7682 and MAP7683.

2.4.2 Source Databases.

The numerous databases involved in the handling and linking of visual/textual data for WEAPDA are summarized in Table 2-11. Some were source databases, while others

were generated by the WEAPDA team. Databases for both video and still image files included data recorded in the field (when adequately provided), along with data generated as a part of the database construction.

The latter was created through researching and cross-referencing the various data sources, including still imagery, maps, and videos, in an attempt to better identify targets. Many "working", or temporary databases were generated in preparation for final linking into the DESERT STORM - DoD database. Listed are the source databases, and the primary databases which catalog specific types of data. Temporary, or "working" databases for internal purposes are not listed.

Table 2-11. Databases used or developed to support the WEAPDA system.

Database Name	Source	Description
DISK_PRO.DBF	HTI	List of CDs produced under phase II sorted on filename
DISK_ERR.DBF	HTI	List of CDs with some type of error
ARK_SCAN.DBF	HTI	DESERT STORM - Uncl. photos scanned at different resolutions
DSV00001.DBF	HTI	Visual data linked to discrete records (Tallil & Al Jaber)
DSV00002.DBF	HTI	Visual records for linking global BE#s
DSV00003.DBF	HTI	Over flow from DSV00002.DBF
DSV00004.DBF	HTI	Overflow from DSV00002.DBF
DSV00005.DBF	HTI	F-16 ADRs ready for linking
F-111.DBF	DIA	Catalog of F-111 ADRs, with Weapda Team annotations
F-117.DBF	DIA	Catalog of F-117 ADRs, with Weapda team annotations
F-15.DBF	HTI	Catalog of F-15 ADRs, with Weapda Team annotations
F-16.DBF	HTI	Catalog of F-16 ADRs, with Weapda team annotations
MEATDB.DBF	DIA	Ed Wolfe's original database of MEA team photos
MEAT_LNK.DBF	HTI	Database edited down from MEATDB, ready for linking
MEA_WORK.DBF	HTI	Sub-set of MEAT_LNK, not ready for linking
STILLS.DBF	HTI	Targets other than Tallii & Al Jaber ready for linking
MISSION.DBF	GWAPS	Original mission database created by Maj. Hill (GWAPS)
TARGETS.DBF	GWAPS	Gulf War Targets Database
V1-1LINK.DBF	HTI	Files linked for version 1.1 delivery

2.4.3 Linking Process.

Additional visual data can be added to any of the databases included in the WEAPDA Version 1.1 system by simply modifying the desired record, or in the case of the DESERT STORM - DoD database an automated visual data import function has been included[2].

In order to use the visual import function to link a new visual to the correct record(s) within the DESERT STORM - DoD database, the system must be provided with the information needed to identify the record(s) to which the visual should be linked. This information must be prepared in a character delimited text file, referred to as the visual update database, with the structure shown in Table 2-12. In the case of the visual type entry, codes have been used to represent the different types of visual data expected (Table 2-13). The delimiter between data entries should be hexadecimal character 16.

This file can easily be created using dBASE® or other COTS database software and exported in character delimited text file format, or it can be created using any text editor. The resulting text file should be saved with the file extension ".wvd" which indicates that it is WEAPDA visual data and will enable the visual import function to automatically recognize the file. The operation of the visual import function is discussed in the WEAPDA Software User's Manual.

Table 2-12. Visual linker file structure.

Data Entry	**Unique Record Identifier**	**Max. No. of Characters**	**Sample entry**
Visual type code (see Table 2-13)		8	VI_ADR
BE number of record(s) to receive file	√	10	1234-56789
Mission number of record(s) to receive file	√	5	1111A
ATO day of record(s) to receive file	√	2	10
Callsign of record(s) to receive file	√	20	GATOR
Linesort of record(s) to receive file	√	1	A
Filename of visual file		12	R2A09999.AVS
Disk label of disk containing file		10	WEAPDA0999
Disk number of disk containing file		4	999
Run time (for motion video)		5	02:21
Audio (T or F)		1	T
Color (T or F)		1	F
Title of visual		20	Hit on Baghdad

[2]Butler, et. al., "Software User's Manual for the Weapons Effects and Performance Data Archival (WEAPDA) System," Horizons Technology, Inc., San Diego, CA, November 1993.

Table 2-12. Visual linker file structure (Continued).

Data Entry	Unique Record Identifier	Max. No. of Characters	Sample entry
File description		254	GBU-15 strike on the Baath party headquarters in downtown Baghdad.
Date of image		12	02/11/91
Source of image		20	Combat Camera

Table 2-13. Visual type codes.

Code	Description
VI_ADR	Armament delivery record video
Code	**Description**
VI_DA	Damage assessment video
VI_OTH	Other video
ST_OVE	Overhead imagery
ST_TR	Tactical reconnaissance photograph
ST_TM	Targeting materials
ST_OTH	Other still imagery
DR_BLU	Blueprint drawings
DR_SD	Structural diagrams
DR_OTH	Other drawings

As discussed earlier, there are five fields which define a unique record in the database (see Section 2.1.1). These are; 1) Basic Encyclopedia (BE) number, 2) Mission number, 3) Air Task Order (ATO) day, 4) Callsign, and 5) Linesort. The linker has been designed to use all or only a portion of those fields in order to determine the correct database record(s) to receive the visual file. If information for all five fields is provided, the linker will link the visual file to that single record which matches all five entries. However, if information on fewer fields is provided, the linker will link the visual file to all records which match those fields

For example, if a post conflict exploitation team still photograph of a particular shelter on Tallil airfield is being inserted into the DESERT STORM - DoD database, it is likely that all five fields will be required to link it to the actual mission(s) that struck that shelter. This stems from the fact that in all likelihood the shelter will not have an individual BE number, but rather be identified as a mensuration point (MP) on Tallil, and be associated with the BE number of the entire airbase. If only the BE number were provided to the automatic linker, then every mission that attacked any structure on Tallil (i.e. is identified with Tallil's BE number) would receive the photograph. This would result in large quantities of extraneous data being linked to records.

In addition, if over the course of the war multiple missions struck that particular shelter, then it will be desirable to have that single photograph linked to each of those missions. In order for the automatic linker to do so, a separate entry is required in the visual update database for each record which should receive the photograph.

If you have digitized photographs of a particular target which maintains its own unique BE number, such as a bridge, which you wish to insert into the system, the linker will greatly simplify your efforts. In such a case, you may provide the linker with only the BE number (of the five unique record fields), and the information associated with the digital photograph, and it will automatically link that photograph to every mission that lists that BE number as the target it attacked.

2.4.4 Unlinked Videos.

The majority of the linking performed was categorized by aircraft. As described in section 2.4.3, a listing of any records failing to link is output as a separate file during the linking process. Due to the information contained, these resulting lists of unlinked video files are classified CONFIDENTIAL and are presented in a project memo[3].

2.4.5 Unlinked Stills.

Due to the information contained, these resulting lists of unlinked video files are classified CONFIDENTIAL and are presented in a project memo[3].

2.5 DATA ARCHIVAL.

A tremendous amount of data has been archived to date under the WEAPDA system. The ADRs from the four aircraft types archived thus far comprise a 300 CD ROM volume set. In addition to this, there are approximately twelve still-image CD volumes. Each WEAPDA volume has a Digital Audio Tape (DAT) backup for the purpose of future replication. As well as processing the large volumes of data, error detection/correction presents additional challenges.

Difficulties have been uncovered concerning the archival of data onto DAT media. During DAT creation, indications given by the system were those of successful back-up completions. There were no indications of error given. Regardless of this fact, some DAT cassette retrieval attempts have indicated that the archived materials were flawed. For those cases where all attempts to recover the data failed, a CD-ROM was requested from one of the user sites in order to re-source the material.

Later data processing software upgrades have provided validity-checking methods to help detect problems with archived materials. In addition, we have implemented a validity

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[3]Mehler, S., "Visual Capture Log Summaries," Horizons Technology, Inc. San Diego, CA, December 31, 1993.

checking process to test the data's integrity prior to release. This testing encompasses both CD and DAT media.

Replication begins with a removable hard drive holding approximately 580MB of captured data. The drive is then loaded onto a CD-ROM Replication System. Comprising the WEAPDA replicators are a 486 tower, chained using a Small Computer Systems Interface (SCSI) to a JVC once-off replication unit, and a DAT drive, as needed. The data contained on the removable drive is then written to the replicator's internal 660 MB hard drive, as an ISO-9660 image. Once the image resides on the internal drive, replication onto CD or DAT is possible. This CD technology has the drawback of being WORM based. If an error was introduced during replication, the resulting disk(s) were virtually useless for any CD-ROM drive not capable of performing a low-level reading of the data. Technology has developed which will facilitate both multi-session and appendability functions, although it is not clear that future tasks will require such a feature.

During archival, related data was grouped prior to being written to the individual CDs. This approach was taken to minimize the amount of "disk swapping" required by a user doing research with the data. The archived data and associated CD-ROM volumes are presented in Table 2-14.

Table 2-14. Data types and associated CD volumes.

Type	Content	CD Volume(s)
Video	F-111 ADRs	WEAPDA 0001-0112
Video	F-15 ADRs	WEAPDA 0113-174A
Video	F-117 ADRs	WEAPDA 0175-0256
Video	F-16 ADRs	WEAPDA 0257-0300
Stills	Howey slides (MEA)	WEAPDA1000, 1001
Stills	BTG, IRP, TR	WEAPDA1003
Stills	MEA photos, DS, GTG, HTG, TR	WEAPDA1004
Stills	MEA photos, BDA, BTG, DS, GTG, HTG, TR	WEAPDA1005
Map	Map data at varying scale	WEAPDA_MAP 2
Multiple	Map data, MEA Photos, early database	WEAPDA0112
Database	Database release, version 1.05	WEAP_DB_1.5
Stills	DESERT STORM - Uncl. PhotoCD images all of disk 1 + half disk 2	ARK-PCD-1-2
Stills	DESERT STORM - Uncl. PhotoCD images 2nd half of 2 + disk 3	ARK-PCD-2-3

Table 2-14. Data types and associated CD volumes (Continued).

Type	Content	CD Volume(s)
Stills	DESERT STORM - Uncl. PhotoCD images all of disk 4+ half disk 5	ARK-PCD-4-5
Stills	DESERT STORM - Uncl. PhotoCD images 2nd half of 5 + most of disk 6	ARK-PCD-5-6
Stills	DESERT STORM - Uncl. PhotoCD images last of disk 6 + disk 7 + some of disk 8	ARK-6-7-8
Stills	DESERT STORM - Uncl. PhotoCD images and some scanned photos	Delivery scheduled 6/94*
Video	DESERT STORM - Uncl. post conflict videos	Delivery scheduled 6/94*

* Final Delivery schedule dpendent upon DNA review of data.

SECTION 3

CONCLUSIONS

Potential applications for multimedia database systems such as WEAPDA appear unbounded. The WEAPDA database in particular will have application to a wide range of user requirements.

To a system analyst, for example, investigating the effectiveness of a weapon system or vulnerability of a target to various weaponeering strategies, the WEAPDA system places available historical data as well as a powerful analysis tool at his fingertips.

For the air campaign planning staff officer charged with reviewing, analyzing, and refining a target list prior to development of the Air Tasking Order (ATO), WEAPDA could be a source of textual and visual data on specific target or historical data relating to "similar" targets. The availability of such information will help the staff officer "visualize" the target.

To the weaponeer, utilizing a weaponeering decision support system, such as DNA's Munitions Effects Assessment (MEA) tool, WEAPDA will provide a source of data rich case studies for various target types. Making use of expert opinion and intelligent technologies, knowledge and experience of these case studies can be applied to "similar" targets for which intelligence data might be limited or non-existent.

To the research engineer, WEAPDA can provide a convenient multimedia database management system for analyzing, archiving and retrieving valuable test data. With networking, various laboratories can share and exchange textual and visual test data results.

To the historian, WEAPDA provides a state-of-the-art historical reference system. By performing simple database queries, the historian can access and review both textual and visual data on a particular event, campaign, weapon system, or test at a single desktop workstation.

The WEAPDA system software database development program will continue with expansion and improvements to the system software and database.

The system shall be expanded to include effects and performance data from past and future conflicts, inclusion of test program data, possible inclusion of hard target imagery from countries of interest, and further refinement and population of the existing DESERT STORM database.

The cost of developing and maintaining stand alone WEAPDA systems (cost of configuration management and replication of multiple sets of CD-ROMs) becomes a concern once the system is replicated beyond the initial three beta test systems. A

promising alternative to stand alone systems is to develop a Wide Area Network (WAN) such as DNA's "DARE" development effort and serve the data to all potential users from a central server location.

Because the data contained in the current DESERT STORM - DoD database is classified SECRET-NOFORN, and much of the data the system is anticipated to retain in the future will have similar classification, the data must be protected during transmission and use. This problem can be simplified by making use of recently developed technology which will encrypt the data before it is written to CD-ROM. This capability has been approved by the National Security Agency (NSA), and is available today. The network administrator can then operate the system in an unclassified, open environment. The CD-ROMs are permanently keyed, so there is no security maintenance required.

Additional plans for WEAPDA include porting to platforms operating under UNIX. This would allow a host of new software systems currently under development to access, query, and import multimedia weapons effects and performance data directly from WEAPDA.

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